CLAIMS

1. A superconducting magnetic field detection element comprising at least one superconducting pick-up loop formed on a common flexible substrate, wherein the common flexible substrate is in a non-planar position, such that the at least one superconducting pick-up loop is operable to detect magnetic fields of differing orientation.

2. A superconducting magnetic field detection element according to claim 1 wherein the common flexible substrate partially extends within a first plane and partially extend within a second plane substantially perpendicular to the first plane such that the at least one superconducting pick up loop is positioned in both the first plane and the second plane.

3. A superconducting magnetic field detection element according to claim 1 wherein the common flexible substrate is positioned such that the at least one superconducting pick-up loop describes an arc subtending a predetermined angle about a nominal focus.

4. A superconducting magnetic field detection element comprising a plurality of superconducting pick-up loops formed on a common flexible substrate, wherein the common flexible substrate is in a non-planar position, such that the plurality of superconducting pick-up loops are operable to detect magnetic fields of differing orientation.

5. A superconducting magnetic field detection element according to claim 4 wherein the common flexible substrate is arranged so as to position each of the plurality of pick up loops in a unique plane which is not coplanar with any plane in which another pick up loop is positioned.

6. A superconducting magnetic field detection element according to claim 5 comprising a first superconducting pick-up loop positioned in a first plane and a second superconducting pick-up loop positioned in a second plane substantially perpendicular to the first plane.

7. A superconducting magnetic field detection element according to claim 5 comprising a first superconducting pick-up loop positioned in a first plane and a second superconducting pick-up loop positioned in a second plane substantially parallel to and spaced apart from the first plane.

8. A superconducting magnetic field detection element according to claim 5 comprising a first superconducting pick-up loop positioned in a first plane and a second superconducting pick-up loop positioned in a second plane such that the first superconducting pick-up loop and the second superconducting pick-up loop describe an arc along the common flexible substrate that subtends a predetermined angle about a nominal focus.

9. A superconducting magnetic field detection element according to any one of claims 1 or 6 to 8 wherein the common flexible substrate comprises Hastelloy tape.

10. A superconducting magnetic field detection element according to claim 9 wherein the Hastelloy tape has a thickness between 50μm and 200μm.

11. A superconducting magnetic field detection element according to any one of claims 1 or 6 to 8 wherein the common flexible substrate comprises a partially or fully stabilised zirconia substrate, such as Ceraflex.

12. A superconducting magnetic field detection element according to any one of claims 9 to 11 wherein a biaxially aligned buffer layer such as yttria-stabilised zirconia (YSZ) is formed over the common flexible substrate in order to improve biaxial alignment of a superconducting material from which the at least one superconducting pick-up loop is formed or from which the plurality of superconducting pick-up loops are formed.

13. A superconducting magnetic field detection element according to claim 12 wherein the buffer layer is deposited by ion beam assisted deposition.

14. A superconducting magnetic field detection element according to claim 12 wherein the buffer layer is deposited by double ion beam assisted deposition.

15. A superconducting magnetic field detection element according to any one of claims 12 to 14 wherein a superconducting material layer such as YBCO is formed over the buffer layer.

16. A superconducting magnetic field detection element according to claim 1 or claim 4 further comprising a SQUID for detecting current induced in the at least one or multiple pick-up loops as a result of a magnetic field passing through the at least one or multiple pick-up loops.

17. A superconducting magnetic field detection element according to claim 16 wherein the SQUID is formed on the common flexible substrate.

18. A superconducting magnetic field detection element according to claim 16 wherein the SQUID is magnetically coupled to the at least one or multiple pick-up loops through a flux transformer formed on the common flexible substrate.

19. A superconducting magnetic field detection element according to claim 18 wherein the SQUID is positioned to allow coupling between the flux transformer and the SQUID.

20. A superconducting magnetic field detection element according to claim 19 wherein the SQUID is mounted against the flux transformer.

21. A superconducting magnetic field detection element according to claim 1 or claim 4 wherein a minimum radius of curvature or twist of the common flexible substrate is controlled in order to avoid damage to the element.

22. A superconducting magnetic field detection element according to any one of claims 6 to 8 wherein the common flexible substrate is twisted in order to provide circuit elements, such as a superconducting pick-up loop, in a third plane.

23. A method of forming an element of a superconducting device for detecting magnetic fields, the method comprising the steps of:

forming at least one superconducting pick-up loop on a common flexible substrate; and

positioning the common flexible substrate in a non-planar configuration such that the at least one superconducting pick-up loop is operable to detect magnetic fields of differing orientation.

24. A method according to claim 23 further comprising the step of partially extending the common flexible substrate within a first plane and partially extending the common flexible substrate within a second plane substantially perpendicular to the first plane such that the at least one superconducting pick up loop is positioned in both the first plane and the second plane.

25. A method according to claim 23 further comprising the step of positioning the common flexible substrate such that the at least one superconducting pick-up loop describes an arc subtending a predetermined angle about a nominal focus.

26. A method of forming an element of a superconducting device for detecting magnetic fields, the method comprising the steps of:

forming a plurality of superconducting pick-up loops on a common flexible substrate; and

positioning the common flexible substrate in a non-planar configuration such that the plurality of superconducting pick-up loops are operable to detect magnetic fields of differing orientation.

27. A method according to claim 26 further comprising the step of arranging the common flexible substrate so as to position each of the plurality of pick up loops in a unique plane which is not coplanar with any plane in which another pick up loop is positioned.

28. A method according to claim 27 further comprising the steps of positioning a first superconducting pick-up loop in a first plane and positioning a second superconducting pick-up loop in a second plane substantially perpendicular to the first plane.

29. A method according to claim 27 further comprising the steps of positioning a first superconducting pick-up loop in a first plane and positioning a second superconducting pick-up loop in a second plane substantially parallel to and spaced apart from the first plane.

30. A method according to claim 27 further comprising the steps of positioning a first superconducting pick-up loop in a first plane and positioning a second superconducting pick-up loop in a second plane such that the first superconducting pick-up loop and the second superconducting pick-up loop describe an arc along the common flexible substrate that subtends a predetermined angle about a nominal focus.

31. A method according to claim 23 or claim 26 further comprising the step of detecting current induced in the at least one or multiple pick-up loops as a result of a magnetic field passing through the at least one or multiple pick-up loops.

32. A flexible superconducting device comprising:

a flexible polycrystallline substrate;

a biaxially aligned buffer layer; and

at least one superconducting component formed over the biaxially aligned buffer layer.

33. A flexible superconducting device according to claim 32 further comprising one or more of the following non-limiting list of superconducting devices: a pick up loop; a ground plane; a strip-line connector; a waveguide; a flux transformer; a Josephson Junction; and, a SQUID.

34. A method of forming a flexible superconducting device, the method comprising the steps of:

providing a flexible polycrystalline substrate;

forming a biaxially aligned buffer layer over the flexible polycrystalline substrate; and

forming at least one superconducting component over the biaxially aligned buffer layer.

35. A method according to claim 33 wherein the flexible superconducting device comprises one or more of the following non-limiting list of superconducting devices: a pick up loop; a ground plane; a strip-line connector; a waveguide; a flux transformer; a Josephson Junction; and, a SQUID.

36. A superconducting gradiometer comprising:

a first pick-up loop defining and substantially residing in a first nominal plane; and

a second pick-up loop defining and substantially residing in a second nominal plane;

wherein the first pick-up loop and the second pick-up loop are formed on a common flexible substrate, wherein the first nominal plane and the second nominal plane are substantially parallel, and wherein the first nominal plane and the second nominal plane are sufficiently spaced apart to allow the first pick-up loop and the second pick-up loop to act to distinguish local magnetic fields from background magnetic fields.

37. A superconducting gradiometer according to claim 36 that is axial and implemented through the use of a superconducting flux transformer pick-up loop structure patterned on the common flexible substrate.

38. A superconducting gradiometer according to claim 37 wherein the flux transformer is inductively coupled to a detection means for detecting current induced in either the first or second pick-up loops as a result of a magnetic field passing through the first or second pick-up loops.

39. A superconducting gradiometer according to claim 38 wherein the detection means is a SQUID magnetometer.

40. A superconducting gradiometer according to claim 39 wherein the flux transformer is positioned between the first and second pick-up loops in order to couple detected flux into the SQUID located proximal to the flux transformer.

41. A superconducting gradiometer according to claim 40 further comprising a flexible strip-line conductor connecting each of the first and second pick-up loops to the flux transformer.

42. A superconducting gradiometer according to claim 41 wherein the SQUID is mounted against the flux transformer.

43. A superconducting gradiometer according to claim 42 wherein the SQUID is sandwich-mounted against the flux transformer in a flip-chip arrangement.

44. A superconducting gradiometer according to claim 41 wherein the SQUID is formed on the common flexible substrate by the formation of a Josephson Junction.

45. A superconducting gradiometer according to claim 44 wherein the Josephson Junction is formed over a step edge etched into the substrate.

46. A superconducting gradiometer according to any one of claims 36 to 45 wherein a biaxially aligned buffer layer such as yttria-stabilised zirconia (YSZ) is formed over the common flexible substrate in order to improve biaxial alignment of a superconducting material from which the first and second pick-up loops are formed.

47. A superconducting gradiometer according to claim 46 wherein a superconducting material layer such as YBCO is formed over the buffer layer.

48. A superconducting gradiometer according to claim 47 wherein a protective layer is provided over the superconducting material layer .

49. A superconducting gradiometer according to claim 47 or claim 48 wherein the flux transformer is formed by patterning a circuit over the superconducting material layer.

50. A superconducting gradiometer according to claim 41 wherein an additional length of flexible superconducting tape covers each of the strip-line conductors forming a ground plane.

51. A superconducting gradiometer according to any one of claims 36 to 50 wherein the common flexible substrate comprises a flexible tape made from Hastelloy.

52. A superconducting gradiometer according to any one of claims 36 to 50 wherein the common flexible substrate comprises Ceraflex tape.

53. A method of fabrication of a superconducting gradiometer comprising the steps of:

forming a first pick-up loop and a second pick-up loop on a common flexible substrate positioned substantially in a single nominal plane; and

subsequently deforming the flexible substrate to position the first pick up loop substantially in a first nominal plane and to position the second pick-up loop substantially in a second nominal plane, wherein the first nominal plane and the second nominal plane are substantially parallel and are spaced sufficiently apart to allow the first pick-up loop and the second pick-up loop to act to distinguish local magnetic fields from background magnetic fields.

54. A method according to claim 53 further comprising the steps of:

forming a flux transformer on the flexible substrate; and

sandwich mounting a SQUID against the flux transformer.

55. A method according to claim 54 wherein the steps of forming the flux transformer and forming the first and second pick-up loops are done simultaneously.

56. A method according to claim 53 further comprising the steps of:

forming a step edge on the flexible substrate; and

forming a SQUID on the flexible substrate, having a Josephson Junction formed over said step edge.

57. A method according to claim 54 or claim 56 further comprising the steps of:

forming a buffer layer over the flexible substrate prior to formation of said pick-up loops; and

forming a protective coating over the first and second pick-up loops.

58. A method according to claim 57 wherein the first and second pick-up loops are formed as part of a superconducting layer over the buffer layer.

59. A method according to claim 58 wherein the buffer layer is biaxially aligned YSZ for promoting biaxial growth of superconducting material in the superconducting layer and for isolating the first and second pick-up loops from the common flexible substrate.

60. A method according to claim 58 or claim 59 wherein the superconducting layer has a thickness between 50nm and 500nm.